ENGINEERING WORKS

OF

CLEVELAND, O.

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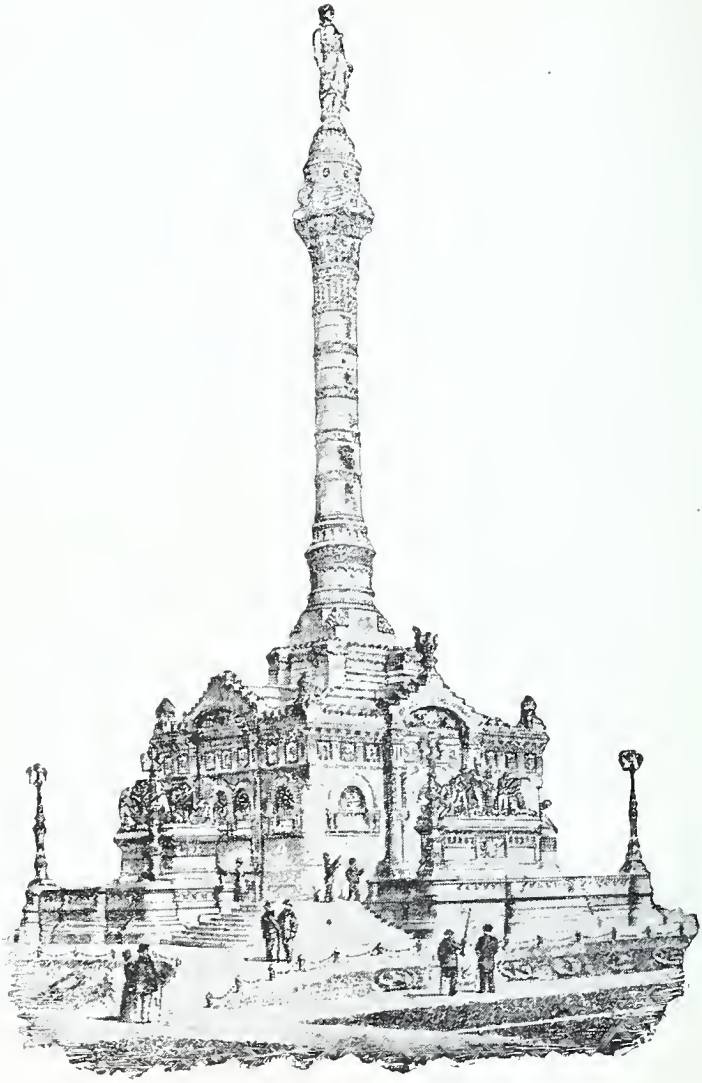

SOLDIERS' AND SAILORS' MONUMENT.

VISITORS' DIRECTORY

TO THE

Engineering Works and Industries

OF

CLEVELAND, OHIO.

Presented with the Compliments of

THE CIVIL ENGINEERS' CLUB OF CLEVELAND.

COLUMBIAN EDITION.

JULY, 1893.

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THE CIVIL ENGINEERS' CLUB OF CLEVELAND.

ORGANIZED MARCH 13, 1880.
INCORPORATED MAY 29, 1891.
MEMBERSHIP, 178.

OFFICERS.

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CHAS. S. HOWE . . . . . *Vice-President.*

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INTRODUCTORY.

IN preparing this volume for the use of visitors to our city in this Columbian year, the Committee has endeavored to present the main facts of interest to an engineer in as concise a manner as possible and without exaggeration or embellishment. It would be impossible in a work of this size to describe all the hundreds of mechanical industries in this busy city; only a careful selection of representative concerns has been attempted, though it is with regret that many deserving works are necessarily omitted. The descriptions are entirely editorial and for the information of the reader, and nothing in the nature of a paid advertisement has been admitted.

It is hoped that the memoranda here furnished will be such as the intelligent engineer would wish to make for himself in the course of his visit, but it is not intended to preclude that personal attention which each member of the committee will feel it a privilege to pay on behalf of the Club to such guests as may honor us with their presence.

Very respectfully,

C. M. BARBER, *Chairman*, E. P. ROBERTS,
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JAS. RITCHIE, F. A. COBURN,
W. H. SEARLES, *Secretary*,

Local Columbian Committee.

HISTORICAL.

CLEVELAND, the largest city in the State of Ohio, and the largest city on Lake Erie, having a population of over 300,000, and increasing at a rate exceeding five per cent. per annum, is not yet one hundred years old.

The city was founded and the first survey of its site made in 1796 by Gen. Moses Cleaveland, whose monument stands in the Public Square.

In 1805, Cleveland was made a port of entry and a post-office was first established here.

In 1809, it was made the county seat.

In 1814, the village was incorporated.

In 1818, the first newspaper was issued and the first steamboat on the great lakes arrived at this port.

In 1825, a pier extending 600 feet into the lake was built.

In 1827, the Ohio Canal was opened from Cleveland to Akron, and in 1832 to the Ohio River.

In 1836, Cleveland received a city charter.

In 1854, Ohio City on the west side of the Cuyahoga river was consolidated with it, the combined population being 20,844.

In 1845, three state banks were established.

In 1846, the first high school in the United States was established here.

In 1849, a gas plant was built and telegraphic communication established.

In 1851, the Cleveland, Columbus and Cincinnati Railroad was opened. The city borrowed $50,000 for building a market and schools; three school buildings had been erected as early as 1838, however.

In 1860, the first street railroad was chartered; the National Bank of Commerce began business, and the Mahoning Valley Railroad was opened for traffic, giving a great impetus to manufacturing industries in great variety.

In 1868, Bessemer steel was produced by the Cleveland Rolling Mill Company, and wooden ship-building was extensively carried on.

In 1870, one-third of the oil product of Pennsylvania was shipped to Cleveland for manufacture and export.

In 1872-73, the villages of East Cleveland and Newburgh were annexed.

In 1877, the stone Viaduct was completed, 3,211 feet long, costing with the swing bridge $2,170,000.

In 1888, the Central Viaduct, giving easy access to the South Side, was erected.

The addition of many other railroad lines converging on Cleveland, the establishment of a liberal water works system, the improvement of the harbor, the chartering of many electric street railways, and the establishment yearly of new industrial enterprises in great variety, have combined with the enormous traffic on the lakes in iron and coal to give to Cleveland a phenomenal growth in population and financial importance.

GROWTH BY DECADES.

Year.	*Population.*	*Year.*	*Population.*
1830,	1,075	1870,	92,825
1840,	6,071	1880,	160,148
1850,	17,054	1890,	261,353
1860,	43,838	1892,	309,243

HARBOR AND BREAKWATER.

Cleveland has a river frontage of sixteen miles, full five miles of which are built up in dockage. Of the latter, one mile is used for passenger landings, warehouses and grain elevators; the balance is devoted to iron furnaces, limekilns, slaughtering and meat packing establishments, but principally to handling immense quantities of iron ore, coal, pig iron and lumber.

The outer harbor is formed by a breakwater extending 7,160 feet west of the entrance and 2,148 feet eastward of the same. It was completed in 1883, and has cost for construction and repairs, $1,167,118. It is to be carried farther eastward.

The breakwater consists of a series of timber cribs, each 50 feet long by 32 feet wide, sunk end to end in line upon a foundation of riprap, in 16 feet of water. The cribs come to the surface, and upon them is built a continuous wooden pier, 10 feet high. The timbers are all of one size, 12 in. x 12 in., framed together and secured by round iron drift bolts 1¼ in. in diameter by 30 in. long. The breakwater is filled with loose stone and covered with a substantial deck. The heavy seas of the lake break over the structure, but do not reach the harbor. The entire cost is about $100 per lineal foot.

MUNICIPAL WORKS.

The following is a brief abstract from the forthcoming report of the City Engineer.

The total amount expended by the city for contract work of all kinds under the direction of the Chief Engineer in 1892 was $796,517.39. The cost of miscellaneous work for the year, including street lighting, was $281,555.31.

STREET PAVEMENTS.

The summary for the past year of work done in this department is as follows:

	Av. price per sq. foot.	Amount.
Medina block-stone pavements, 6 streets,	29.75 cts.	$ 78,840.71
Medina common stone pavements, 5 streets,	20.5 cts.	53,342.30
Brick pavements, 10 streets,	14.23 cts.	82,680.34
Wood pavements and planking on bridges,		2,339.43
		$217,202.78

All stone and brick pavements for the year were laid directly upon earth foundations, and the joints filled with asphaltic cement. The earth foundations for brick pavements were thoroughly rolled. Settlement in this class of pavement laid since 1889 is almost unknown, the sand and gravel of nature, when rolled, being apparently equal to broken stone. No asphalt pavements have been laid during the past year. The

total length of asphalt pavements now in use is one and one-quarter miles. New work proposed for the coming year, one and six-tenths miles.

Thirty streets have been graded, or graded and curbed, during 1892, at a cost of $31,766.81. The average price of 5 x 20 inch domestic sandstone curbing, in place, was 33⅓ cents per lineal foot.

SEWERS.

During 1892, the length of main and local sewers built aggregated $18\frac{2}{10}$ miles, at a cost of $266,992.69.

The Broadway sewer, completed in 1892, is the most important in the southern part of the city, extending from Miles avenue to Kingsbury Run, about four miles, and serving a large territory, including Newburg. A number of storm water overflows have been constructed along its line. An important sewer is projected for Walworth Run, having a maximum diameter of $17\frac{5}{10}$ feet, circular, on a grade of 0.5 per 100, diminishing gradually to a diameter of 8.25 feet on a grade of 0.8 per 100. It can have no storm overflows on account of its depth.

Total length of main and branch sewers, 197.87 miles.

Total number of house sewer connections, 19,660.

Total number of catch basins, 4,150.

BRIDGES.

The New Swiss Street Bridge, just finished, is one of the most substantial and permanent bridges in Cleveland. Its length is 250 feet; width over all, 56 feet; roadway 38 feet, with two sidewalks 8 feet each in the clear. The grade line is 35 feet above Walworth

CLEVELAND VIADUCT (SUPERIOR STREET.)

Run. It crosses over Walworth street by four steel plate girders 66 feet long over all, 7 feet high, resting on masonry abutments. Riveted between these girders are cross girders, supporting 15-inch 75 lb. rolled I beams, which are about four feet apart and run lengthwise of the bridge.

A steel plate floor $\frac{5}{8}$ inch thick is riveted to the upper flanges of the I beams, and is stiffened with angle iron riveted on the under side. The plates support three inches of gravel ballast, and on this is laid a pavement of Medina dressed block stone with asphaltum cement joints, making a water-tight finish. The sidewalks are of Portland cement concrete on arches of the same. The remainder of the structure consists of longitudinal brick walls and cross walls, the latter supporting 15 inch, 80 lb. I beams four feet apart, in lengths of about 15feet. These are covered by a concrete floor about 16 inches thick, and upon this are placed ballast and a stone pavement as on the steel span. The sidewalks are also constructed in a similar manner. The masonry rests upon a foundation of firm blue clay. The total cost was about $65,000.

There are in all, ten swing-bridges belonging to the city, and ten railroad swing-bridges. There are forty-one fixed bridges, city and railroad.

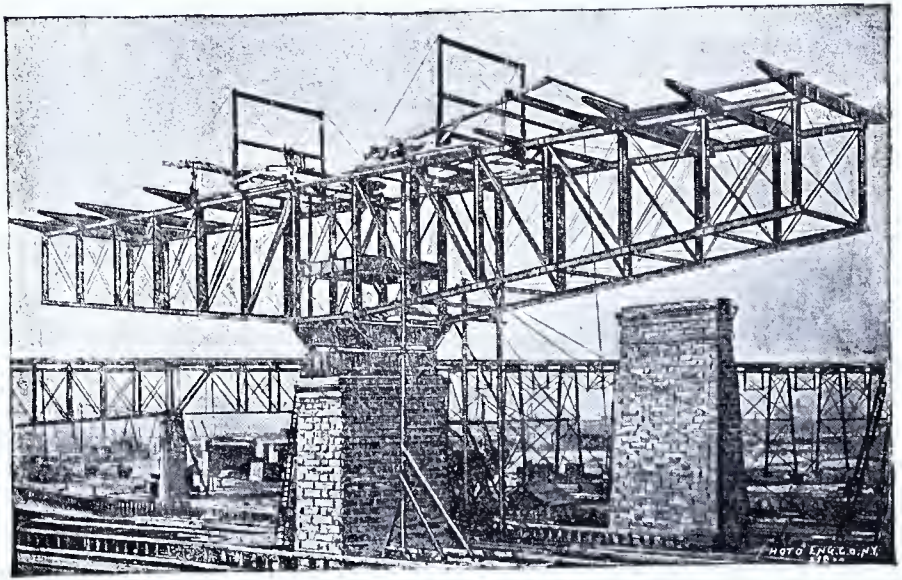
THE SUPERIOR STREET VIADUCT was begun in August, 1874, and completed December 27, 1878, the time of construction being four years, four months. The cost of entire work was $2,250,000, of which $650,000 is charged to right of way. It consists of a swing-deck span 332 feet long by 46 feet wide, the floor being

70 feet above the water. The eastern approach is of iron, 598 feet long, on masonry foundations. The western approach consists of ten arches of cut stone, eight of which are of 83 ft. span, and two of 97½ ft. span, terminating in a solid filling between retaining walls; the width is 64 feet. Total length of viaduct, 3,211 feet. The weight of the swing span is 570 tons; of the turntable, 105 tons. The bridge is opened in one minute by a 50 H. P. engine. The iron work of the east approach weighs 792 tons. The masonry contains 2,025,000 cubic feet, and rests on 227,000 lineal feet of white oak piling.

THE KINGSBURY RUN VIADUCT has a total length of 834 ft. 8 in., having one span of 140 ft., six of 60 ft., two of 45 ft. and eight spans of 30 ft. each. Its width is 48 ft. in the clear, its height above masonry is 75 ft. 6 in.; above the run 87 ft. and above the foundation 96 ft.

The work was begun November, 1884, and completed in June, 1886; time, 19 months. It is an iron structure on stone foundations, resting on piling.

THE CENTRAL VIADUCT crosses the Cuyahoga valley, and the Walworth Run valley, the two portions having been built under one contract. The Cuyahoga portion is 2,838 ft. long by 56 ft. wide. Its height is 101 ft. above the river. It consists of a series of spans of iron and steel, supported on iron towers which rest on cut-stone foundations. The swing span over the river is 239 ft. long, and rests on piers of cut stone. The viaduct crosses obliquely over the iron viaduct of the New York, Chicago & St. Louis Railway, the track of which is 68 ft. above the river surface.



CLEVELAND CENTRAL VIADUCT SWING,
Showing erection without False Work.
BUILT BY THE KING BRIDGE CO.

THE WALWORTH RUN portion is 1,092 ft. long by 56 ft. wide. Its height is 76 ft. 6 in. above Scranton avenue. Its construction is the same as the Cuyahoga portion. Both are paved with wooden blocks in asphaltum. The entire contract was undertaken by the King Bridge Co. in May, 1886, and completed in December, 1888. Time, 2 yrs. 7½ mos. The cost was $675,574, exclusive of right of way.

CITY PARKS.

The Parks of the city are nine in number, with an aggregate of 213.13 acres.

GORDON PARK, containing 119.81 acres, was recently bequeathed to the city by the late W. J. Gordon, by whom it had already been brought to a high degree of cultivation and improvement. It is protected on the lake side by a sea-wall of solid masonry. Drives and foot-paths, lawns, groves and fish-ponds diversify its surface.

WADE PARK, containing 63.5 acres, borders on Euclid avenue at the East End. It has a fine stream of water, fountains, and a small lake for boating. The nucleus of a zoological garden is here, containing already many varieties of birds and beasts. This park was presented to the city some years ago by the late J. H. Wade. It is to be connected with Gordon Park by a fine boulevard two miles long.

LAKE VIEW CEMETERY, one mile east of Wade Park, though not included in the list of city parks, deserves mention here for its natural scenery and costly improvements in great variety. Here stands the Garfield Monument, erected by the citizens of the United States to the memory of the late President, JAMES A. GARFIELD. The monument consists of a circular stone tower 50 ft. in diameter and 165 ft. high, flanked by two smaller towers and a rectangular porch. It stands on a high parterre reached by a broad flight of stone steps. The interior decorations are very fine. In the centre stands a statue of GARFIELD, beneath which is the crypt containing his ashes. The mausoleum cost about $150,000 and was dedicated May 30, 1890.

MONUMENTAL PARK, in the heart of the city, contains 4½ acres. Here stands the bronze statue of Moses Cleaveland, founder of the city. The Soldiers' and Sailors' Monument, in granite, bronze and marble, occupies the easterly quadrangle. From a base 100 ft. square rises a polished shaft to a height of 110 ft., upon whose capital stands an emblematic figure of Liberty, 15 feet in height. This monument was erected by Cuyahoga county at a cost of $200,000.

EUCLID AVENUE, of world-wide renown, extends easterly from Monumental Park to Lake View Cemetery, a distance of five miles. With its fine shade trees, broad lawns and palatial residences widely separated from each other, its park-like character is well maintained from end to end.

MOSES CLEAVELAND.

WATER WORKS.

The city is supplied with water by the direct pumping and reservoir system combined, and is divided into low and high service districts. The water for the low service district is pumped to a height of 170 feet above Lake Erie, and that for the high service district to a height of 155 feet additional.

The source of supply is Lake Erie. The crib containing the two inlet shafts is situated about 6,600 feet from shore. From the crib the water flows through two tunnels to the pump wells at the pumping station, and is then forced by five pumps through five mains to all parts of the city, and to the low service reservoir. The reservoir is used for regulating the pressure in the mains, receiving the excess of water pumped over that consumed, and furnishing a supply in addition to the pumps if needed; also, in case of the stoppage of all pumps, it can supply the whole city for a few days.

Near the reservoir at the corner of Woodland Hills and Norman street, is located the high service pumping station, which draws its supply from the low service reservoir through two 30-inch mains, one from each basin; and also (in case of emergency only) from one of the 36 inch reservoir supply mains. The water is forced through a 30-inch main to the high service district, and to the high service reservoir situated on Kinsman street.

The construction of the original water works was begun in 1854, and water was first supplied to the city in the year 1856. The intake at that time was located only 300 feet from shore; from this a 50 inch wrought iron pipe led to the shore, connecting there with a brick aqueduct, five feet vertical and four feet horizontal diameter, and 3,000 feet long, to the pumping station fronting on Division street. Two low pressure Cornish beam pumping engines, of a combined capacity of eight million gallons daily, furnished the city with water at that time.

The water works plant at present consists of one crib in Lake Erie; two tunnels, one five feet in diameter and one seven feet in diameter; one low service pumping station; a low service system of supply and distributing mains, and a low service reservoir. Also a high service pumping station, supply and distributing mains and high service reservoir.

PROTECTION CRIB.

The crib is pentagonal in form, with an open space in center for shaft. It has a floor eight inches thick built of 8x12 timbers; on this are built three walls, all of 12x12 pine timbers, securely fastened with drift bolts and screw bolts. Each side of the outer wall is 54 feet long; each side of the inner wall (which encloses open space) is nineteen feet long; the distance from outside of outer wall to inside of inner wall is 24 feet, and midway between these two is the middle wall, also built up solid and joined to the outer wall by cross walls of timber, thus dividing the crib into a number of compartments. It is thoroughly tied and braced with 12x12

inch timbers, and sheathed the whole height with 2x12 oak plank on the face of all three walls. At the water line it is encircled with a ½x36 inch wrought iron band. The angles of the crib, from this band to the upper floor of crib, a distance of about 12 feet, are further strengthened by iron angle-plates lapping two feet on each side. Suitable inlet ports, connecting the well in the center of the crib with the lake, were provided and are about ten feet above the bottom of the lake.

The superstructure or house is a framework of timber sheathed with 6x12 inch timbers, outside of which the 2x12 inch oak plank are also spiked; the roof is made of two layers of 1⅛ inch matched flooring. At the center of the conical roof the light-house is built. The crib, which is 61 feet high to upper floor, is located about 6,600 feet from shore in 38 feet of water; its pockets are completely filled with stone. It settled no less than thirteen feet into the bottom of the lake, which is a blue clay. This settlement occurred before riprap stone was placed around the crib, after which there was no more settling.

TUNNELS.

Two tunnels lead from the crib to the pumping station. The daily capacity is estimated at 150 million gallons. The first tunnel, five feet two inches vertical and five feet horizontal diameter, was commenced August 23d, 1869, and finished March 29th, 1874, water being drawn through it on the day following. The length of tunnel from shaft in crib to that on shore is 6,661.61 feet. It is lined with two rings of brick laid in

cement mortar, with one-half inch space filled with mortar between rings. Depth of lake shaft below surface of water is 90.2 feet; depth of shore shaft below surface of water is 67.5 feet. Internal diameter of each shaft is eight feet.

The land tunnel extending from the shore shaft to the pumping station is of same dimensions as lake tunnel; it was commenced in March, 1876, and completed in September of same year. The length is 2,580 feet. The material through which the lake tunnel was built is unstratified blue clay, varying in solidity, at one place being so soft that a shield had to be used in order to hold the clay back long enough to permit the masonry to be put in.

Considerable gas, water and quicksand were encountered during the building of this tunnel, and about 832 feet of completed tunnel [the sand for this distance being continually washed away by the water from a spring] settled so much that it had to be abondoned and a new tunnel built in place of it, about 73 feet west of and parallel to this abandoned part; no trouble was encountered on the last line.

The second tunnel, seven feet two inches vertical diameter and seven feet horizontal diameter, was commenced in June, 1888, and finished in November, 1890. This tunnel is built on a nearly straight line from crib to pump station. The inlet shaft at the crib was sunk in a compartment of the crib between the outer and middle wall, the stone having been removed and the bottom cut through. Five shafts were sunk for this tunnel, three on the pump station grounds, one in the crib and one—a temporary working shaft—near the lake

shore. When the lake shore shaft was nearly completed, a vein of quicksand and gravel with strong flow of gas and water were struck, which entirely filled the shaft with water and sand so that it had to be abandoned, and a new shaft sunk 150 feet to the westward. North of this shaft, gas, sand and water were four times encountered in such quantities as to cause the abandonment of about 680 feet of completed tunnel, and after three successive turnouts had been made without getting past the bad ground, an air compressor plant was erected at the shore shaft, the airlock being placed 634 feet north of the shaft. The tunnel was then completed without difficulty under air pressure varying from 32 pounds per square inch when encountering gravel, quicksand and gas, to six pounds in ordinary clay. A pressure of about sixteen pounds was necessary in very soft clay to prevent its creeping or swelling in. No bracing was required nor any shield, the compressed air supporting the clay sides of the excavation perfectly, until the lining could be built. This tunnel is 9,200 feet long; it is lined with three rings of brick laid in cement mortar with one half inch of cement mortar between rings.

Under compressed air the south heading was steadily advanced a distance of 3,574 feet north of the air-lock, to meet the north heading which was driven from the crib shaft. The position of the air-lock was never changed. Compressed air was also used in the north heading. No quicksand, water or gas were encountered in this heading, but pockets of very soft clay were passed through and the air pressure was used on this account.

PUMPING STATIONS.

The low service pumping station is situated on the low ground just south of the old river bed, at foot of Kentucky street.

The buildings are all of brick on stone foundations, the older building resting on two cross courses of 12x12 inch timber, two feet deep, placed twelve inches apart, with all the spaces between timbers filled with concrete.

The new building and the additions to the older ones have a pile foundation ; piles being 25 feet long under the buildings and 35 feet long under the chimneys.

These buildings contain six pumps, two Knowles of fifteen million gallons daily capacity each, three Worthingtons of ten million gallons daily capacity each, and one ten million gallon Henderson engine; a total of 70 million gallons daily pumping capacity. All these are low duty horizontal direct acting duplex engines. The Henderson engine will this year be replaced with a fifteen million gallon Worthington high duty engine.

In order to raise the water to a height of 170 feet at Fairmount reservoir, a head equal to 193 feet has to be resisted at the pumps. Steam for these engines is furnished by 25 boilers of the tubular and the marine type, ten of these are in daily use, with five as a reserve. The remaining ten are used in connection with the reserve pumping engines. The average daily quantity of water pumped at the low service station during 1892 was 36½ million gallons. (36,500,000).

The high service pumping station is built of stone, and rests on solid rock about eleven feet below surface. The old Cornish engines originally in use at the low

service station were overhauled and placed in this building. Daily capacity, 8,000,000 gallons.

STAND-PIPE.

The tower enclosing the stand-pipe is built of stone to the height of engine house, and from this point up of brick. Its extreme height is 230 feet above the surface of the ground. It is connected with the engine house by a short passage way. The stand-pipe is about 203 feet high above the surface of the ground; it is four feet diameter at the base, and three feet diameter at the top and made of Otis steel, the thickness of plates ranging from $\frac{7}{16}$ at the bottom to $\frac{1}{4}$ inch at the top. A spiral stairway is provided between the stand-pipe and tower.

PIPE SYSTEM.

Five mains, two 36 inches, two 30 inches and one 24 inches, leading from the low service pumping station and spreading to all parts of the city, constitute the principal supply mains. They are connected at short intervals with the smaller distributing mains and also with each other, forming a complete network throughout the city, and are finally continued as two 36 inch mains to Fairmount reservoir in the eastern part of the city. At times, when the consumption of water during the day is greater than the pumps in use can furnish, the water flows back from the reservoir into the mains to maintain the supply, the quantity thus drawn from the reservoir being restored by the pumps during the following night.

The mains and reservoir for the high service system are used in the same way.

There are in use 36 miles of supply main, varying in size from 36 inches to 16 inches, and 324.6 miles of distributing main, of from twelve inches to four inches in diameter.

RESERVOIRS.

The low service, or Fairmount reservoir, is bounded by Fairmount, Baldwin and Quincy streets, Woodland Hills avenue, and N. Y., C. & St. L. Ry. Its greatest length is about 1,500 feet, and greatest width 700 feet. The bottom is 150 feet above Lake Erie, and the water line 170 feet. The top of embankment is five feet higher than water line.

The reservoir is divided into two basins by an embankment across it at the center. The north basin has an area at water line of 351,000 square feet, and a capacity of 47 million gallons.

Area of south basin, 254,000 square feet; capacity, 33 million gallons. Total capacity of reservoir, 80 million gallons. The embankment is sixteen feet wide on top, inner slope is 1¾ to one, and outer slope two to one. It is built of yellow sand lined on the inside slopes with 2½ feet of puddled clay; on top of that a layer of six inch broken stone and then four inches of gravel, finished with a ten inch pavement of sandstone.

The ground was excavated to four feet below finished bottom line, on this was placed 2½ feet puddled clay; four inches of gravel on top of that and on that one foot of concrete. The material for building this reservoir was all found on the ground with the exception of the paving stone and cement. The ground consists of yellow sand, gravel, hard blue clay, interspersed

with vertical strata of pipe clay, and under this blue shale rock.

The high service reservoir is situated on the north side of Kinsman street, five miles east of Public Square; the construction is practically the same as that of the low service reservoir, except that the embankment is built entirely of clay, that material being most convenient.

Elevation of water level 325 feet, elevation of bottom of reservoir 302 feet, area of basin at water line 255,810 square feet, capacity 37,000,000 gallons, greatest length 780 feet, greatest width 765 feet.

The works are owned by the city and are self-supporting. The water rates to consumers are reduced from time to time when it is found to be practicable to do so.

Total cost of construction to Jan. 1, 1893,	$6,367,492 94
Net earnings during 1892	466,014 47
Bonds outstanding	1,775,000 00
Average consumption per day in gallons	36,442,985
" " " inhabitant	117
" " " consumer	143

GAS WORKS.

Cleveland is supplied by two gas companies, one on each side of the river.

The Cleveland Gas Light & Coke Co., in the East Side, is much the larger of the two. Its officers are: J. H. Morley, president; Malcolm S. Greenough, vice-president and general manager; C. H. Beardslee, secretary; G. A. Hyde, engineer; J. C. Heath, assistant engineer. Authorized capital, $2,000,000. The office is at 356 Superior street. The old works are located near the foot of Water street. These were begun in 1846, and have been increased from time to time until the limit of available space was reached. The new works are located at the extreme easterly limit of the city near the Lake Shore Railway. They contain regeneration benches of nines and other modern improvements after the French system. They are now producing gas, although the works are not finished. When completed they will contain much labor-saving machinery, reducing the cost of manufacture. The works produce coal gas; the quality is eighteen candle power and is tested by an inspector appointed by the city. The gas is sold at a cheaper rate than in any other large city in the United States, the price being eighty cents per 1,000 feet, out of which six and one-half per cent. is paid into the city treasury. The net

revenue to the Gas Company is therefore 74.8 cents per 1,000 feet, which compares very favorably with most European prices. The output for 1893 is estimated to be about 750,000,000 cubic feet.

ELECTRICAL WORKS.

Cleveland is known to the world as one of the first cities in which electricity was successfully applied for lighting and power purposes. This reputation has been maintained through the successful enterprise of the Brush Electric Company and other corporations more recently established here.

THE BRUSH ELECTRIC COMPANY, now a part of the great General Electric Company, operates a plant covering seven acres and employing 750 men. The works are on Mason street, near the C. & P. Railway.

The business was established in 1876 under the name of the Telegraph Supply Company. The present name was adopted in 1880, and the capital stock was finally fixed at $2,000,000.

The inventions of Chas. F. Brush were among the first to make electric lighting commercially successful. He was the first to construct a dynamo with current regulator and arc lamp, which made it possible to operate a large number of electric lights in series on one wire.

The company manufactures, under various patents, dynamo-electric machines for arc and incandescent lighting, electric motors, lamps and carbons, electro-plating machines, current regulators, and a large number of other improved electric machines.

Connected with this company, and also included in the General Electric Co., is the SHORT ELECTRIC RAILWAY COMPANY, organized in 1889 and capitalized at $5,000,000. The motor first turned out was of the double reduction type, which proved both efficient and economical. This was followed two years later by the single reduction motor, and this in turn by the gearless machine, a type so unexpected as to cause great surprise. This is the characteristic machine of this company; at the same time careful attention has been paid to the development of their generator. There are now fifty-five roads in different parts of the country using the Short machines.

THE CLEVELAND ELECTRIC LIGHT CO. have a large plant in operation in a four story building in the rear of 117 Public Square. They supply most of the electric lamps used in the city.

THE BRUSH ELECTRIC LIGHT AND POWER COMPANY have a plant on Lime street, at the foot of Michigan.

THE SOCIETY FOR SAVINGS have a handsomely appointed electric plant for lighting their own building. There are also some other private plants in the city.

THE POWER STATION of the East Cleveland Railroad Company is located on Cedar avenue at the C. & P. Ry. crossing. The present buildings are 80 x 100 and 80 x

140 feet, and the addition, now in course of erection, will make the total area 240 x 140 feet. The boiler equipment at present consists of fourteen boilers, 72 inches by 80 feet, and 130 horse power each, with steam at 100 pounds. All are supplied with the Murphy Smokeless Furnace and Automatic Stoker. Water is supplied by an artesian well 8 inches diameter and 377 feet deep, with a capacity of 100,000 gallons in twenty-four hours. The water rises to within seventy-five feet of the surface. The present steam engine equipment consists of three 250 horse power 18½ x 18 inch Armington & Sims engines, running at 200 revolutions, and three 125 horse power 14½ x 15 inch engines, of same type, running at 260 revolutions per minute, and two 500 horse power 28 x 48 inch Cooper engines, making seventy-two revolutions. The fly-wheels of the latter are twenty feet diameter by fifty-two inch face and weigh twenty-five tons each. The high speed engines are belted directly to the generators; the low speed engines to a line shaft in four parts, aggregating seventy-nine feet. On this there are six 88 x 29 inch split friction-clutch pulleys so arranged that either of the two engines, which are at the ends of the shaft, can run the entire line or each may run one-half separately. The receiving pulleys are 74 x 50 inches. Either of the generators can be stopped or started independently. The generators are sixteen in number, of the Edison compound wound type, and vary in capacity from 40 to 150 K. W. each. They hold the voltage within a maximum range of ten volts. Two more generators, 150 K. W. each, are to be added soon. The armatures are kept cool by streams of cold air coming from the basement.

C. W. Wason is vice-president and electrical engineer; R. M. Fuller is assistant electrician.

The Power House of Woodland Avenue & West Side R. R. Co. is located just west of the river, on the north side of the Superior Street Viaduct. The building is 160 x 140 feet; the stack is 175 feet high. There are three 500 horse power boilers of the Scotch marine type. There are three triple expansion marine engines with two-foot stroke, running at 140 revolutions, making the piston speed 560 feet per minute. Coupled to an extension of the engine shaft at each end is a Westinghouse multi-polar generator of 250 horse power, designed to run at 140 revolutions. The direct connection of triple expansion engine and generator has never before been attempted, but the result is most satisfactory. The engines and boilers were constructed by the Globe Iron Works of Cleveland.

The switchboard is of enameled brick ten feet six inches long, on an insulated foundation. The measuring instruments of the Westinghouse type are bolted to the brick-work, and connections through it are made by means of rubber tubing.

The Brooklyn & South Side R. R. Co. owns three power stations, one located on Pearl street, near their office, one on Canal street, near Central Viaduct, and one on Scovill avenue, corner of Florence street; all three plants feed into the general net-work.

The Pearl Street Station is the largest of the three. It contains five 150 horse power boilers. Water was taken from an artesian well, but this caused so much scale it had to be abandoned for city water. Five Ball

engines are used to drive ten Thomson-Houston generators of 62,500 watts capacity. Each engine has two fly-wheels and the belting is direct.

At the *Canal Street Station* there are six boilers of 150 horse power each. Seven Ball engines of 125 horse power each are belted directly to as many Thomson-Houston generators.

The Scovill Avenue Station is of brick, 88 x 48 feet, and has a stack 165 feet high. It contains three 150 horse power boilers, eighteen feet long, equipped with the Roney Mechanical Stoker. Slack coal is used as fuel. There are five 16 x 24 "Straight Line" engines, and these are belted directly to five Thomson-Houston generators of 62,500 watts capacity each. The switchboard is supplied with Thomson-Houston instruments.

THE POWER STATION of the Broadway & Newburgh Street R. R. Co. is located at Broadway and Aetna street, nearly at the center of the system, and also near the steepest grades. The building is of brick, 62 x 325 feet. There are five 200 horse power boilers. Four Allis-Reynolds-Corliss engines are used; one of 600 horse power makes seventy-two revolutions per minute. The fly-wheel, twenty-four feet diameter, has a double crowned face and is connected by two twenty-four inch belts to two No. 80 Edison generators of 150 K. W. capacity each, having receiving pulleys of thirty-six inch diameter, making about 550 revolutions. The other three engines are of 250 horse power each, and each has double sixteen-foot fly-wheels, making eighty revolutions. They are connected by eighteen inch belts to six Edison 80 K. W. generators, with pulleys

twenty-six inches diameter, making about 700 revolutions per minute. The switchboard is of marbleized slate, and is provided with the latest forms of circuit breakers and lightning arresters. The front section of the building is used for storing cars.

THE FORD-WASHBURN STORELECTRO COMPANY have their works on Frankfort street, near Water street. They construct electrical machinery generally, but make a specialty of their storage battery car, which has been running about one year. The battery consists of 180 cells of 150 ampere-hours capacity each. Each cell is $4\frac{1}{2} \times 8$ inches and 12 inches high, and weighs, with acid and rubber box, forty pounds. The motor is thirty-five horse power, series wound, and weighs 2,000 pounds. The car is twenty-eight feet over all and weighs complete about seven tons. It can be run at any speed up to twenty miles an hour. One charge of the battery suffices for a run of forty miles.

STREET RAILWAYS.

The street railways of Cleveland have been owned and operated by six companies until the present year. They are now owned by two consolidated companies, The Cleveland Electric Railway Co. and The Cleveland City Railway Co.

THE CLEVELAND ELECTRIC RAILWAY CO. is formed by the consolidation of the East Cleveland R. R. Co., the Broadway & Newburgh R. R. Co., the Brooklyn Street R. R. Co. and the South Side Street R. R. Co. Its capital stock is $12,000,000, and bonded debt $1,500,000. Its officers are: Henry A. Everett, president; Horace E. Andrews, vice-president; R. A. Harman, secretary; L. E. Beilstein, assistant secretary; C. W. Wason, electrical engineer and purchasing agent; Jas. Parmelee, treasurer; John J. Stanley, superintendent; Hon. Tom L. Johnson, chairman of board of directors; A. L. Johnson, chairman of executive committee. It operates 54.34 miles of double track road within the city limits. It has single track extensions to Collinwood and Euclid 4 miles, total 112.68 miles of single track. All the lines are operated by electricity, with overhead trolley wires.

The rails are of the Johnson and the Wharton patterns, and range in weight from 52 to 90 lbs. per yard. The rails are connected by copper rail-bonds, which are soldered to a continuous ground wire. The trolley wire is No. 0 hard drawn copper.

THE CLEVELAND CITY RAILWAY CO. is formed by the consolidation of the Woodland Avenue & West Side Street R. R. Co. (32 miles), and the Cleveland City Cable Co. (19¼ miles). It is capitalized at $8,000,000. Its officers are: M. A. Hanna, president; Frank DeH. Robison, vice-president; J. B. Hanna, secretary; Geo. G. Mulhern, superintendent. It operates the Superior Street and Payne Avenue lines by cable, 19¼ miles single track; all the rest by electricity or horses. It is contemplated to dispense with horses in favor of electricity the present year. The recent track is laid with Johnson rail, 82 and 98 lbs. One mile is laid with Wharton rail, 90 lbs., and 9 inches high. Each rail is wired both sides at the joints, with No. 00 galvanized iron wire. The trolley wire is of copper No. 0, B. & S. The motors generally are of the Westinghouse single reduction type. Two 25 H. P. motors are placed on each car. The cable roads were built in 1890. The rail is the Wharton girder, 72 lbs. per yard, the joints resting on the yokes. The yokes are of cast iron, weigh 365 lbs. each, and are placed 5 ft. apart, c. to c. They rest on beds of concrete. The conduit is oval in form, is 18 inches deep inside, and consists of cement concrete laid in place upon wooden folding cores. The carrying pulleys are of chilled cast iron, 16 inches diam. and 35 ft. apart. The curve pulleys are 42 inches diam. and have removable rings with chilled grooves.

The power-house is a handsome building of pressed brick, located on Superior street at Kirtland street. The stack is 150 ft. high. It contains three Babcock & Wilcox boilers of 362 H. P. each. The fuel is crude oil piped direct from Lima, O., to an iron reservoir in the

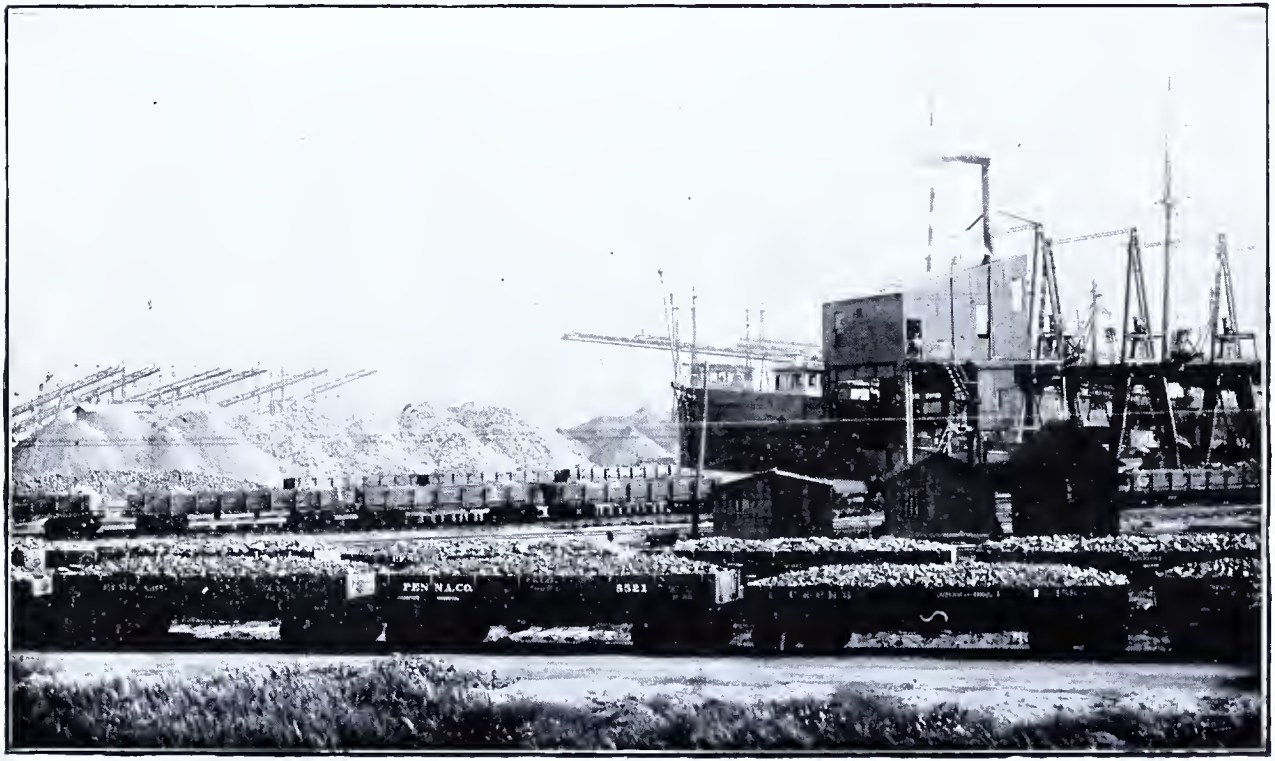
station. The oil is burned in the form of spray mingled with a jet of steam. The burners are fed from a small pump giving from 5 to 8 lbs. pressure. There are two engines of 1250 H. P. each, cylinders 38 x 60 inches, built by William Wright, of Newburgh, N. Y. They are geared, one at each end of the main shaft, which is 16 inches diam. and 90 ft. long. Either engine is capable of driving the entire machinery, and one is held in reserve. Each fly-wheel is 24 ft. diam. and weighs 65 tons. The pinions on the main shaft are 5 ft. diam. by 12 inch face. Each one engages with a pair of gears 13 ft. diam., which are mounted on the driving drum shafts. The drums are of several sizes, according to the cable speed required. The main shaft is in three sections, of 30 ft. each. These terminate in large disks, facing each other and two inches apart, giving a space through which to pass the cable when necessary. The disks are connected by a steel key set into the face of each disk and secured by bolts. The pinions are connected to the shaft by friction clutches so that either set of drums may be stopped at pleasure. The drums have differential rings. All the winding machinery was supplied by the Walker Mfg. Co. of Cleveland. Four cables are in operation; the plant is designed for six. An overhead traveling crane is provided, capable of handling the heaviest piece in the plant. Some auxiliary machinery is placed in a chamber under Superior street on the Public Square. East of this the cable has a speed of 12 miles an hour, west of it 6 miles an hour; the first cable drives the second by suitable drums and gearing. The cables east of the power station have a speed of 14 miles an hour. The lengths of the cables

respectively are: Superior street, east 23,900 ft.; west 24,300 ft., auxiliary 7,850. Payne avenue, east 26,300 ft.; west 24,050 ft. The road and plant were designed and erected by the late Col. William H. Payne, of the Brooklyn Bridge, New York, assisted by Mr. Robert Gillham.

THE IRON INTEREST.

IRON ORES.

The Lake Superior Iron Mines produced in 1890 no less than 9,003,701 gross tons of ore, the sale and movement of which was conducted by sales agents in CLEVELAND, who are also owners of the mines to a large extent. Here the ore docks at all Lake Erie ports, except Buffalo and Erie, are controlled, and here is owned fully 80 per cent. of the vessel property engaged in this commerce, which forms the largest single item in the lake traffic. The capital involved on July 1, 1892, in mining the output of the Lake Superior iron mining district and in transporting the same by lake and rail, was $175,394,985. More than sixty four million gross tons were produced in this district since 1855 up to January, 1892, and the ore is the finest in the world. The value of the ore at the Lake Superior mines averaged in 1889, $2.66 per ton. The distance of transport of ore by water averages about 600 miles. Nine-tenths of the output is shipped by water.



SCENE ON THE IRON ORE DOCKS.

The actual receipts of iron ore by lake at the port of Cleveland for the five years 1888 to 1892 inclusive are as follows: 971,775, 1,742,415, 1,945,492, 1,257,775, 1,950,224; total, 7,867,681 gross tons. The iron ore stored on Cleveland docks May 1, 1893, was 628,639 gross tons.

BLAST FURNACES.

Cleveland has four large blast furnaces with five stacks, having a total average annual capacity of 275,000 net tons, the value of the product being $4,000,000, at a low estimate. The fuel used is coke, and the ore comes from Lake Superior.

The Cleveland Rolling Mill Co. owns two furnaces here; one, the *Central Furnace*, on the river flats, has two stacks; the other, the *Newburgh Furnace*, has one stack. The capacity of the three stacks is 180,000 net tons annually. The product is mainly No. 1 Bessemer pig.

The Union Rolling Mill Co. owns the "*Emma*" *Furnace*, recently remodeled. The annual capacity is 55,000 net tons; the product, Bessemer foundry and forge pig iron.

Pickands, Mather & Co. own the *River Furnace*, on the river flats. Its annual capacity is 40,000 net tons; the product is high grade foundry pig.

IRON AND STEEL MILLS.

The annual capacity of the iron and steel mills of Cleveland is as follows:

	Net Tons.
Bessemer and open-hearth steel, blooms, billets and slabs	545,000
Rails	100,000
Wire rods	288,000
Merchant bars and shapes	108,500
Plates, axles, iron and steel forgings, etc.	210,000

OTIS STEEL COMPANY, LIMITED.—The Otis Steel Works, sold to an English corporation three years ago for about $4,000,000, of which $3,000,000 was paid in cash, are the largest, most thoroughly organized and profitable plant engaged exclusively in the manufacture of steel in the United States. The works occupy about 24 acres on the lake shore, at the foot of Lawrence street, and are equipped with the best modern machinery, tools and appliances to economize labor and material. The capacity is 80,000 tons of steel per annum, chiefly boiler and ship plates, tires and axles, billets and forgings. The "Otis steel" is in high repute throughout the United States as a specialty. A large amount is consumed in this city.

For the manufacture of steel plate, bar steel and forgings, of which the annual capacity is 40,000 net tons, this company has two rotary puddling furnaces, fourteen Siemens heating furnaces, nine hammers, seven 15-ton open-hearth steel furnaces, and three trains of rolls. In addition, there are two 5-ton converters (capacity about 40,000 tons annually), for the production of Bessemer steel for wire rods used largely by the American Wire Works, which are controlled by Cleveland stockholders in the Otis Works.

Oil is used for fuel to some extent; the company has its own gas works, and pumping plant drawing water from the lake. About 1,100 hands are employed in all departments.

LAKE ERIE IRON COMPANY is located at the mouth of the river, on the west side. The plant consists of sixteen single puddling and nineteen heating furnaces,

four trains of rolls and thirteen hammers. The annual capacity is 19,000 net tons. The product is locomotive and car axles, iron and steel forgings, iron shafting up to 20 inch diameter and merchant bar iron. The company also owns a nut and bolt works, located at the foot of Oxford street.

THE CLEVELAND ROLLING MILL COMPANY. — The business of this concern was started in 1857 by Chisholm, Jones & Co., who, six years later, incorporated the present company with a capital of four million dollars.

The works occupy seventy-five acres at Newburg. In September, 1892, there were employed in the various departments no less than 3,500 hands. The mines and vessels engaged in furnishing iron ore to the blast furnaces are controlled by a separate company.

This great corporation bears a most important relation to the advancement of Cleveland as a manufacturing city. The plant in several departments has been and is now being remodeled on a grand scale. A new blooming mill has just been constructed at a cost of $250,000, and preparations are now being made for the adoption of the direct process in the manufacture of low phosphorus steel. This will necessitate the building of an entire new steel mill, with three 10-ton converters, upon which work will begin during the present year.

Its present works have a national reputation for the manufacture of almost every variety of steel and iron. The products, irrespective of blast furnaces, include Bessemer and open-hearth blooms, billets and slabs,

beams, channels, angles, and all other structural shapes, Bessemer steel rails, small T and tram rails, steel wire rods, merchant, spring, toe-calks and sleigh-shoe steel, steel tires, hoops and forgings, wire, plain and barbed, steel boiler and tank-plate, galvanized and black sheet iron, and corrugated roofing and siding.

The present Bessemer steel works have two 10-ton converters, with an annual capacity of 180,000 net tons of ingots, and the open-hearth steel works comprises two 15-ton and two 7-ton open-hearth furnaces, with a capacity of 40,000 net tons of ingots. The capacity of the blooming mill is 250,000 net tons of blooms, billets and slabs, and the rail mills, comprising five heating furnaces and one train of rolls, have an annual capacity of 125,000 tons; the wire mills have an annual output of 50,000 tons of finished wire; structural and bar mills, capacity 55,000 tons of merchant bars and shapes; plate mills, with six puddling furnaces, nine heating furnaces, two busheling furnaces, eight knobbling fires and four trains of rolls, and a galvanizing works attached, with an annual capacity of 15,000 tons. The company also has a foundry, a forge, machine shops, and barb-wire fence manufactory.

Oil, and gas made from oil, are used largely as fuel in these works.

The Union Rolling Mill Company is located in Newburgh. The works cover seven acres of ground and employ about 400 hands. The mills have been in operation since 1875; the present equipment is of the very best. The present company was organized in 1880 with a capital of $500,000. The works comprise nineteen

single puddling furnaces, six heating furnaces with Siemens gas producers, and three trains of rolls. The daily capacity is 120 tons of finished iron, including bar iron, angles, fish plates, steel rails and shafting. The specialties are "Union Refined" bar, and cold-straightened shafting.

THE CLEVELAND CITY FORGE AND IRON COMPANY is located on Case avenue, at the corner of Lake street. The works cover ten acres and are fully equipped with machinery of the heaviest class. They supply the heaviest forgings known to iron masters, either of iron or steel, in the rough, rough-machined, or finished complete. Single forgings of 100 tons each can be dealt with. Only one other forge in the world, that of the Krupps in Germany, can compare with the Cleveland Forge. The company supplies shafts, beams, sternposts and rudders for the new U. S. Navy, as well as for the merchant marine, both of the great lakes and the ocean. It also furnishes the necessary forgings for marine and other engines, hydraulic and special machinery. The product in car axles amounts to 110,000 annually. The company also make the celebrated pressed turnbuckles of wrought iron or steel, the patented Chapman jackscrews, coupling links and pins, etc.

THE BRITTON IRON AND STEEL COMPANY, at the foot of Wason street, on the lake shore, have been producing annually 10,000 net tons of black and galvanized iron and steel plates and sheets, but it is now proposed to erect two 20 ton open hearth steel furnaces and a universal mill for heavy plates. The mill, which was built in 1853, was remodeled last year. There are

six single puddling and six knobbling furnaces, ten heating furnaces, five trains of rolls and one hammer.

THE BRITTON ROLLING MILL COMPANY was organized in 1892. The works are at the foot of Hoyt avenue. They produce iron and steel plates and heavy sheets, with a capacity of 6,000 net tons annually. There are three heating furnaces and one 24 inch by 72 inch train of rolls. Additions are being made for the manufacture of black plates for a tinplate industry.

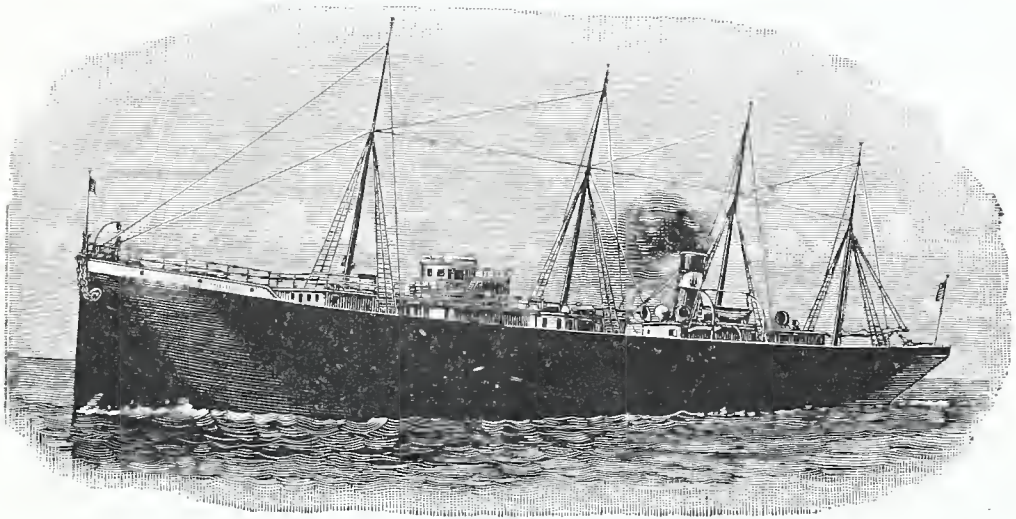
SHIPBUILDING.

Cleveland is now the largest shipbuilding point in the United States and is second only in the world to the famous Clyde district of Scotland. The reports of the U. S. Commissioner of Navigation show that the building of vessels of all kinds at Cleveland has been as follows:

Year.	*No. of Boats.*	*Gross Tonnage.*
1887	21	22,014
1888	24	25,940
1889	22	32,227
1890	24	39,095
1891		31,827
1892		23,920

Of the above, the vessels of iron and steel were as follows:

Year.	*Gross Tonnage.*
1890	28,630
1891	26,523
1892	21,528



TUSCARORA, LEHIGH VALLEY LINE.

BUILT BY THE GLOBE IRON WORKS COMPANY.

There are eight shipbuilding and dry dock establishments in the city, making a return to the last Census Bureau as follows: Capital, $2,587,775; hands employed, 2,083; cost of wages the year, $1,188,662; material, $1,442,045; miscellaneous expenses, $73,921; value of product, $3,091,300.

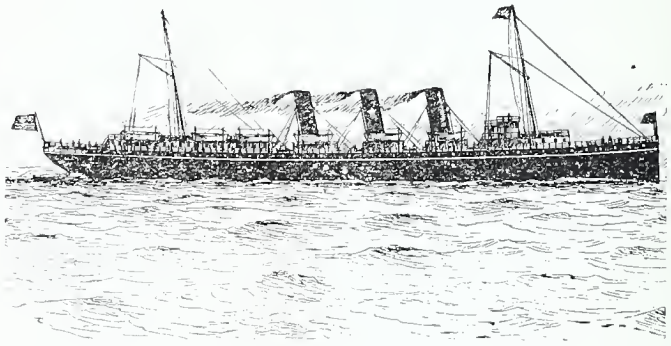
Globe Iron Works Company,

Cor. Center & Spruce Streets.

H. M. Hanna, President.
J. F. Pankhurst, Vice President and General Manager.
Luther Allen, Secretary and Treasurer.
Walter Miller, Mechanical Engineer.

The Globe Iron Works was established in 1853 for the purpose of manufacturing marine machines, boilers, etc. In 1884, the Globe Ship Building Company was organized to build iron and steel hulls for vessels, being the first to engage in that industry on the Ohio lake coast. In 1886, the two enterprises were combined, and the Globe Iron Works Company was incorporated with a capital of $500,000. The office and works for the machinery department occupy the square bounded by Center, Elm, Spruce and Hemlock streets, while the foundry covers more than half a block on Center, Elm, Spruce and Main streets, the company here being extensively engaged in the manufacture of marine machinery and as steel and iron workers, machinists and founders. The office building is a handsome structure at Center and Spruce streets. Among the other buildings are a large four story machine works and large buildings for foundry, boiler and forge shops. The machinery equipment includes great steam cranes

and overhead railways for moving heavy material and products with the greatest ease, powerful lathes, planers, boring machine and other devices. The foundry has two cupolas, each of ten tons capacity. The company's iron ship-yard has a frontage of 1,400 feet upon the estuary of the Cuyahoga River known as "Old River Bed," at the foot of Taylor street, where they have space to build four very large ships at the same time. Vessels' keels are laid parallel with the stream, and the complete hulls are launched broadside. Tramways extending to all parts of the yard, ponderous and powerful machinery



NORTHERN STEAMSHIP CO.'S TWIN SCREW PASSENGER STEAMER.

of every appropriate description, a derrick of 100 tons capacity for placing boilers and machinery in the holds of vessels, and other improved machines are included in the plant, and there is also a complete planing and saw-mill where all the furniture and finishing work of vessels is turned out. The entire works employ 1,200 workmen, with an average weekly pay-roll of $13,000. 15,000 tons of metal are consumed annually. From in-

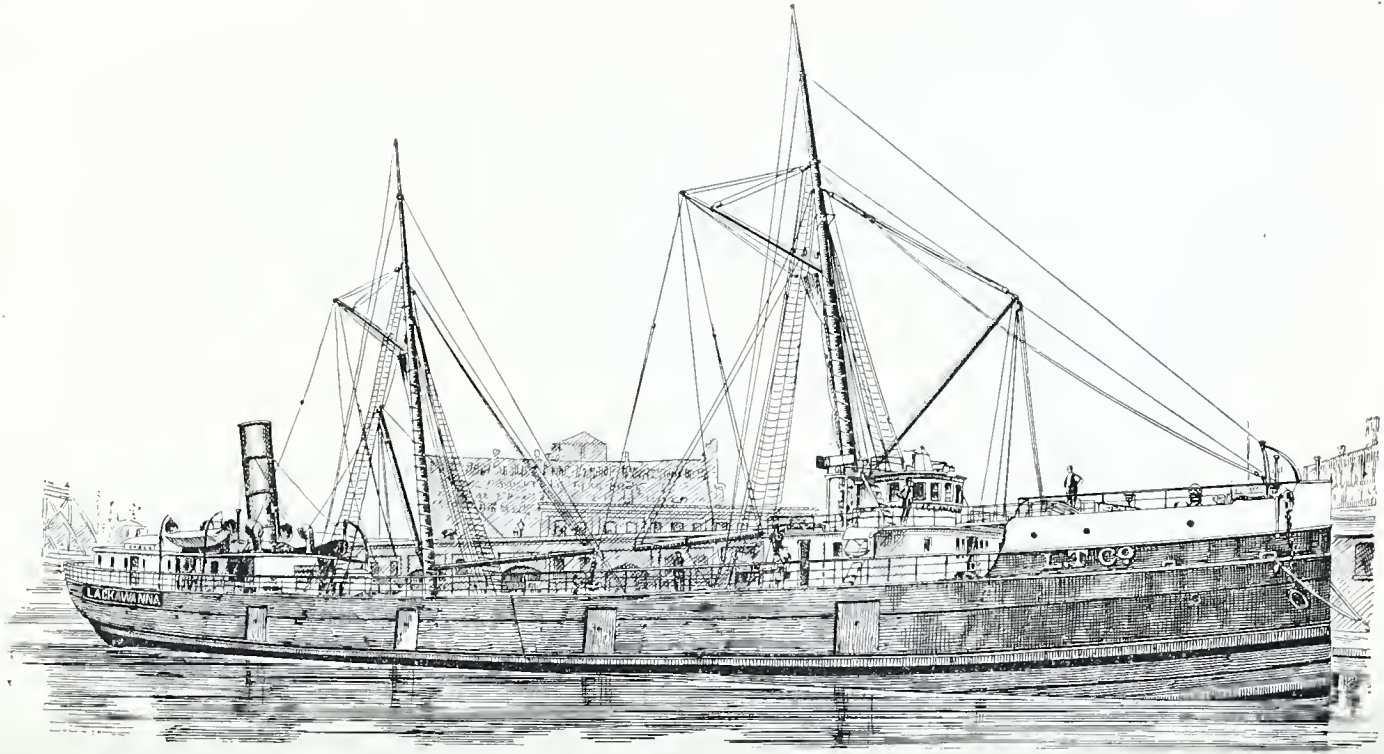
corporation in July, 1886, to June 1, 1892, the company have launched 31 large steel freight vessels, the $300,000 twin-screw steel passenger steamer, Virginia, for the Goodrich Transportation Company, plying between Chicago and Milwaukee, and the auxiliary ocean going steam yacht Comanche, for H. M. Hanna, these vessels all representing the most improved construction, and many of them the greatest achievements in artistic finish. They also built the Ideal steel fish boat, and other vessels of smaller dimensions. Their steam-steering engine, steam-capstan windlass, and combined hoisting and pumping engines, are all of peculiar interest and merit.

The Cleveland Ship Building Company,

120 Viaduct.

H. D. Coffinberry, President.
Robert Wallace, Vice President.
Wm. M. Fitch, Secretary.
Jas. C. Wallace, Assistant Manager.
Arendt Angstrom, Naval Architect.

The Cleveland Ship Building Company was organized in 1886 and incorporated under the laws of Ohio. It purchased the property and good-will of the Cuyahoga Steam Furnace Company, then fifty years old and the pioneer establishment of the kind in northern Ohio. The ship-yard extends 760 feet along the west bank of the river, with two berths accommodating two of the largest lake crafts at once. The mold loft, 185x40 feet, and joiner shop, 75x40 feet, are on a higher level, and all the tools are housed under them. The plate furnace is 8x16 feet, the angle furnace, 3½x45 feet, and the



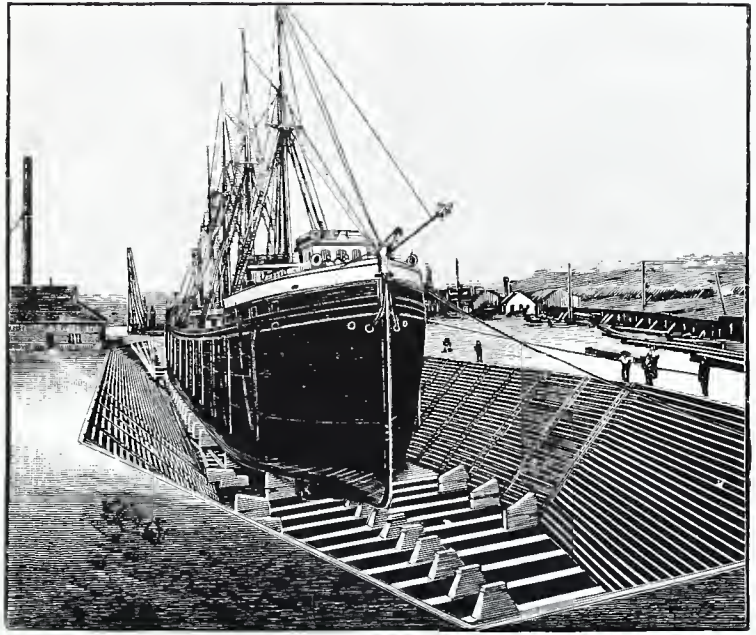
FIRST VESSEL BUILT BY THE CLEVELAND SHIP BUILDING COMPANY.

bending slabs of 800 square feet are in front of them. Two overhead traveling cranes, 44 feet span and two tons capacity each, extend over the building berths and convey material from the yard to either ship. The yard is fully supplied with heavy and other tools. The boiler shop, of brick, 227x85 feet, contains an overhead traveling crane, 30 feet span, 15 tons capacity, and hydraulic crane of 25 tons capacity, also hydraulic riveter, flanger, etc., besides rolls, planers and other tools. The machine shop is of brick, five stories high, 103x54 feet. The fifth floor fronts on the Viaduct, and here are the general offices of the company. The foundry is of brick, 192x77 feet, and is specially fitted up for producing heavy castings. In the five years since the yard was equipped, it has turned out no less than 17 steam vessels, having an aggregate length of 4,428 feet, gross tonnage 27,892, and horse power 15,110. The largest one was 318 feet long, 41 feet beam, 25 feet deep, tonnage 2,415, horse power 1,400. In addition the company has built 15 compound or triple-expansion engines, and boilers for vessels built elsewhere. It has built a number of blowing engines for blast furnaces. It has also built for the Cleveland City Forge and Iron Company the largest steam helve hammer in the United States.

Ship Owners' Dry Dock Company,
Yard, Old River Bed, foot of Weddell street.

Thomas Wilson, President.
Gustav Cold, Secretary.

This is the largest dock-yard on the great lakes. There are two docks. The dimensions of dock No. 1 are 340 feet on keel blocks, 50 feet width of gate, 16 feet depth



SHIP OWNERS' DRY DOCK CO.

on keel blocks. The dimensions of dock No. 2 are 336 feet length by 14 feet depth on keel blocks, width on bottom 45 feet, on top 85 feet. The sides and ends slope at 45 degrees and are faced with altars of 10 inch rise and tread. The gate entrance is 47 feet wide at sill and 55 feet on top, with 15 feet 4 inches water on the sill. There is a double-faced diaphragm gate of wood, well braced, and supplied with four wickets, 24 inches in diameter. There are two vertical pumps with 24 inch discharge, driven by two horizontal engines, 18x20 inch cylinders. There are three boilers, 6 feet diameter by 16 feet long. This equipment will empty the basin in 40 or 45 minutes when docking a vessel of average size. Being equipped with Lucigen lights, work can be carried on at night as well as by day.

The yards for the construction of wooden vessels, which thirty years ago presented scenes of great activity, have yielded to the modern demand for iron and steel vessels, and for the most part have been permanently closed. Plants for the repair of wooden hulls, however, are connnected with the dry docks.

A depth of water in lake harbors of only fifteen feet limits the draft of hulls. The present locks of St. Mary's Canal have the same depth on the sills, but when the third lock now under construction is completed in 1896, it will admit of the passage of vessels drawing 21 feet. A corresponding deepening of the shallow channels between lakes, and of the principal harbors, will then revolutionize the lake marine.

The new lock will be 800 by 100 feet, with a lift of 18 ft. 2 in. Its cost will be $5,000,000.

ENGINEERING INDUSTRIES.

Among the 2,300 manufacturing establishments of Cleveland enumerated in the last census are a number which are of special interest to the engineer by reason of their magnitude, their wide reputation and the peculiar nature of their product. We shall endeavor to describe a few of these.

THE BROWN HOISTING AND CONVEYING MACHINE COMPANY.—The Brown Hoisting and Conveying Machine Company, working under the various patents of Alexander E. Brown, has for twelve years past been erecting on the lakes and elsewhere machinery specially designed for hoisting and conveying iron ore. It is a positive acting automatic machine, that will take material either from or to any desired point on its line and raise, lower or dump the same at the will of the operator. It hoists from vessel, car or mine, and is equally useful in conveying material across rivers or ravines,—a clear span of 1,500 feet being possible,— or carrying material long distances over rough or hilly country. Among the styles of conveyers, the principal are bridge, shed, cable and suspended beam tramway systems, which, with the bucket truck, sheaves, friction clutch, hook, etc., are all of improved design, secured by patents. The company also manufactures automatic dumping buckets, a patent furnace hoist for charging blast furnaces and kilns, and a steam power traveling crane with

cantilever extension. The company employ from 300 to 500 men. Its machines and systems are largely used abroad as well as in this country. Seventy-five per cent. of the ores coming from the Lake Superior district to Lake Erie are handled by this machinery. The bridge and shed tramways are used by leading dock companies, railroad companies, and coal handlers at lake ports. They are used in large numbers to remove the rock from the excavations of the great Chicago Drainage Canal now in progress. The company are now building for the Philadelphia & Reading Coal and Iron Company a plant at East Buffalo, including an iron storage building, 674x354 feet, with 75 feet clear space, holding 250,000 tons of hard coal. Four bridge tramways will be used for handling the coal, and special traveling cranes are being built for this plant. With this company's special machinery, vessels getting to dock at 6 A. M. can leave at 6 P. M., after discharging 3,000 tons of iron ore. The company was incorporated in 1880 with $100,000 capital, and its office and works occupy premises, 300x285 feet, four stories high, at Hamilton and Belden streets.

THE KING BRIDGE COMPANY.—The King Bridge Company of Cleveland, Ohio, have one of the largest plants in the country for bridge and structural work. Their plant is located at the head of Ruskin street, near St. Clair street, on both the Pennsylvania Company and Lake Shore and Michigan Southern Railroads. The company have under roof an area of 155,000 square feet and have been uninterruptedly engaged in business since 1858; first under the name of Z. King, who built the first iron bridge west of the Rocky Mountains; then

BRIDGE OVER THE OHIO RIVER, BETWEEN CINCINNATI, O., AND NEWPORT, KY.

DESIGNED AND BUILT BY THE KING BRIDGE CO.

LENGTH OF CANTILEVER CHANNEL SPAN, 520 FEET. TOTAL LENGTH OF BRIDGE, 2916 FEET.

as Z. King & Son, the firm consisting of Z. King and James A. King; and finally incorporated as the King Bridge Company. This gives them an experience of thirty-four years in manufacturing and erecting bridges, buildings and structural work. Valuable improvements have been made from year to year in the style and details of their bridges.

The King Bridge Company furnishes not only bridges, but iron and steel work for buildings and roofs, etc., for furnace plants, mills, or any style of fire-proof construction desired; also hoisting and conveying machinery for handling ore, coal, etc. They have recently added a plant for the manufacture of steel eye-bars by the latest and most improved methods, and are now one of the few manufacturing companies able to make this class of material.

Their works are supplied with the latest improvements in machinery. The company has erected over two hundred miles of bridges. Among the latest is the large steel cantilever bridge between Cincinnati and Newport, erected during the years 1890 and 1891, at a cost of $2,500,000. The entire structure, including the foundations, was built by this company. The large Kingsbury Run and Central Viaducts, Cleveland, Ohio, were also constructed by this company. Among buildings which they have constructed are the Palm House, Lincoln Park, Chicago; the iron and steel work for the Mines and Mining, Agricultural and Horticultural buildings of the World's Columbian Exposition, Chicago; and the iron and steel work for the market building of the Sheriff Street Market and Storage Company at Cleveland, Ohio.

The Walker Manufacturing Company.

Works, foot of Waverly Avenue.

J. B. Perkins, President.
John Walker, Vice Pres. and Gen. Man.
W. H. Bone, Manager.
Z. M. Hubbell, Sec. and Treas.

The works were founded in 1882; the company was reorganized in 1891 with a capital of $350,000, when the works were reconstructed and greatly enlarged. The works cover about six acres, and the equipment is unexcelled in the country. They give employment to 550 men. The machine shop is 170 feet wide and is built in three bays, two of which are 288 feet in length and the third 430 feet. Each bay is provided with a 30-ton traveling crane of improved construction, built by the Walker Manufacturing Company. The cranes are driven by a 24 x 48 inch Corliss engine through a rope gear. All the machinery is calculated to perform the heaviest kind of work and to finish it with the greatest precision. Among the tools is a lathe with a 72-inch swing and bed 40 feet long capable of carrying between centres a forging of twenty-five tons; a planer with table 27 feet long and stroke of 26 feet; a Gleason gear planer of large size, and a pit lathe 86 feet long, 12 feet wide and 25 feet deep.

The foundry, which is a model of its kind, is 118 by 300 feet in three bays, the center one being 41 feet high to the tie-beams. It is provided with two 30-ton and two 12-ton traveling cranes. It is well lighted and free from smoke. The old foundry adjoining is also in use. There are four cupolas; two are 60 inches diameter, one 72 inches and one 84 inches. They

WALKER MANUFACTURING COMPANY FOUNDRY.

will melt on an average 13.10 pounds of iron per pound of coke. The blast is supplied by a vertical blowing engine 14 x 30 inches, with two air cylinders 48 by 30 inches. All the coke, iron and limestone is raised by hydraulic power developed in a 14-inch accumulator of 14-foot stroke, with an average pressure of 1,000 pounds per square inch by differential pumps, making 150 revolutions per minute. The elevator can raise 12,000 pounds. The core ovens are 24 x 30 feet and 20 x 30 feet respectively and are heated by underground flues. The carriages are operated by gearing and crank handles. Mechanical sand sifters are used. The casting pits range from 12 to 24 feet in diameter and some are 25 feet deep. The foundry is heated in winter by hot air delivered by a Sturtevant blower through an inlet 42 inches square at the rate of 50,000 cubic feet a minute. The pulley moulding machines and the gear moulding machines are most interesting. They execute work with remarkable speed and accuracy.

Of special importance among the productions of this company is the Walker patent differential cable drum, with separate ring for each wrap of cable, dispensing entirely with any wear of the grooves or of the cable while on the grooves. These drums are now in use throughout the United States, at Sidney, New South Wales, and at Staffordshire, England, Four drums, 32 feet diameter, weighing 104 tons each, were recently delivered to the Broadway Cable Road, New York. The largest gear wheel ever made in America, weighing 66¾ tons, was built at these works for the diamond mines of South Africa. The product of the company also includes cable machinery of all sorts, traveling cranes,

complete outfits of hydraulic machinery, bloom shears, riveting plants, boiler-making machinery, wire-mill machinery, rumbling mills, etc.

THE HILL CLUTCH WORKS, located at the foot of Waverly avenue, adjoining the Walker Manufacturing Company, have well equipped machine shops. They manufacture power transmission machinery, the specialty being the Hill friction clutch and cut-off coupling, which is largely used in electrical plants and manufacturing establishments. Some of the machinery in these works is peculiarly interesting.

THE VARIETY IRON WORKS were established in 1866. It employs 350 men. The company has two distinct plants, one at 55 Scranton ave., the other on Hamilton, near Case ave., and these comprise boiler shops, bridge shops, machine shops, a foundry, blacksmith shops and facing mills. They make a specialty of high-grade boilers, but build also tanks and stills, iron buildings and bridges, paper mill and other heavy machinery and furnish foundry supplies. The officers are: L. M. Pitkin, pres. and treas.; F. L. Chamberlain, secretary; Chas. F. Lewis, engineer and superintendent.

THE EXCELSIOR IRON WORKS COMPANY are located at Columbus and Leonard streets. They manufacture steel boilers, mining and quarry machinery, and marine engines, revolving derricks, hoisting engines, coal and ore buckets and dump cars. The officers are: Geo. W. Short, president; Thos. Fleming, vice-president; John Stovering, superintendent; and L. D. Johnson, secretary and treasurer.

THE MCMYLER MANUFACTURING COMPANY, located at 180 Columbus street, make a specialty of manufacturing the McMyler patent revolving derricks, which are extensively used in handling coal and ore on the docks at lake ports. They also make ore buckets and dump cars. John McMyler and E. F. Atherton are the proprietors.

THE CHISHOLM STEEL SHOVEL WORKS is one of the largest of its class in the United States. These goods have the merit that the metal portion of each shovel, spade or scoop is made in a single piece without weld or rivets. The works consist of handsome buildings on Case ave. and the C. & P. railway. The same parties also manufacture Murgatroyd's patent hoisting engines, elevators, land and marine hoisting and transmitting machinery for coal, ore, etc. The proprietors are Wm. Chisholm, Sr., & Sons.

THE LAKE SHORE FOUNDRY, O. M. Burke, pres. and treas.; C. E. Burke, vice-pres. and supt.; Geo. B. Thomas, secretary, is located at the foot of Alabama street. It has a daily melting capacity of 300 net tons, and employs 500 men. The product is cast iron pipes for gas and water in sizes from 3 to 48 inches; also car, bridge and general castings.

CAR WHEEL WORKS.

Cleveland has five concerns engaged in making car-wheels, with a capacity for 335,200 wheels annually.

THE CLEVELAND WHEEL AND FOUNDRY COMPANY, (Maher & Brayton), at 20 Carter street, makes cast iron wheels and does general foundry work. They have 4

cupolas, with an aggregate capacity of 150 tons daily, and employ 250 men.

BOWLER & CO., 14 Winter street, and also Bessemer avenue, have two distinct plants, with a capacity for 100,000 wheels annually. They employ 200 hands and turn out chilled wheels for cars, engines and trucks—also steel tired wheels and street car wheels, railroad and other heavy castings and architectural iron work. Under the title of the Cleveland Frog and Crossing Co., they manufacture the Lucas patent steel rail frog and crossing, spring rail frogs, split switches and track supplies.

THE FULTON FOUNDRY COMPANY (S. M. Carpenter and C. J. Langdon and W. E. Haycox), of 202 Merwin street, has a capacity for 20,000 chilled car wheels for all purposes and 1,200 steel-tired wheels. They also produce turn-tables, transfer-tables, and track castings, and trucks for electric cars, radial draw bars, etc.

DORNER & DUTTON'S FOUNDRY, located at Newburgh, has a capacity of 25,000 chilled wheels per annum. They manufacture a truck for electric cars which has gained a wide celebrity. It is solid forged, non-teetering and has elliptic springs and patent brake. The factory and offices are at 50-52 Fall street.

THE PAIGE CAR WHEEL COMPANY manufactures a steel-tired wheel of remarkable strength and finish by certain ingenious processes peculiar to themselves. The product amounts to 14,000 tons a year. Their office is in the Hickox building.

WIRE RODS, WIRE AND WIRE NAILS.

This industry is more largely developed in Cleveland than in any two other cities in the world. There are four establishments engaged in the manufacture of these products, as follows:

THE CLEVELAND ROLLING MILL COMPANY, already noticed under another head, page 42, has an annual capacity for 125,000 tons of rods and 55,000 tons of wire.

THE HP NAIL COMPANY began the manufacture of wire nails in 1879. It employs 700 men and has an annual capacity for 55,000 gross tons of rods, 55,000 net tons of wire, and 1,000,000 kegs of nails. Coal gas is used in the heating furnaces and fuel oil under boilers. The works are situated near the foot of Case avenue, and cover about three acres. The wire nails include all sizes and styles, from the largest spikes and boat nails down to window shade nails and the smallest wire tacks. The company also makes rivets, staples of all sorts, and basket hooks, etc. All are made by machinery, and each form of article requires its special automatic machine, the whole forming a most interesting and instructive study. The officers are, S. H. Chisholm, pres.; C. B. Beach, vice-pres.; E. C. Beach, sec.

THE BAACKES WIRE NAIL COMPANY.—Although only put in operation in 1891, this company, whose managers contemplate the erection of furnaces for the manufacture of wire and nails from the ore to the finished product, is already engaged in rolling rods, drawing wire and making nails. The capacity, annually, is 40,000 net tons of rods, 40,000 tons of wire and

600,000 kegs of nails. The company owns twenty acres of property at the eastern extremity of the city on the lake shore. The equipment includes, in addition to heating furnaces, rolls and nail making machines, eighteen boilers with engines aggregating 5,800 horse power, and a large gas works, together with galvanizing plant and barb wire fence works.

THE AMERICAN WIRE COMPANY, which is closely allied to the Otis Steel Company, began business in 1886 rolling wire rods. A specialty is now made of galvanized, tinned and coppered wire. Employment is given to 1100 hands, many of them skilled workmen. The plant for making rods comprises one Belgian rod mill with four gas producers, three heating furnaces and four trains of rolls, one continuous rod mill with three gas producers, two heating furnaces and three trains of rolls. The rods are manufactured from steel billets in one continuous operation. The capacity is 75,000 net tons of rods annually. The equipment includes thirty-six boilers and seven engines, aggregating 25,000 horse power.

UNION STEEL SCREW COMPANY.

Works, Corner Case and Payne Avenues.

FAYETTE BROWN, President.
J. A. BIDWELL, Superintendent.

THE NATIONAL SCREW AND TACK COMPANY.

Works, Quincy Street, at C. & P. R. R.

W. D. B. ALEXANDER, President.
D. ELLIOTT, Vice-Pres. and Gen. Supt.
C. W. BRAINERD, Secretary.

These are two large concerns manufacturing steel, iron and brass wood-screws, tacks and small nails, bolts

and nuts. They are equipped with automatic machinery in great variety for this special work. They are entirely distinct interests, with a total capital of $750,000, and they employ, all told, about 450 hands.

THE CLEVELAND MACHINE SCREW COMPANY,
131 Second Ave. Capital stock, $200,000.

THOMAS H. WHITE, President.
HOWARD WHITE, Vice-President.
J. D. CLIMO, Secretary.
W. T. WHITE, Treasurer.
J. B. CLYNE, Superintendent.

This company manufactures automatic screw machines for making milled screws, specialties, etc.; also have 150 of these machines in operation. The factory is new and of the latest modern slow-burning construction. Have been in operation eighteen months.

NUTS, BOLTS AND WASHERS.

In these articles, the Cleveland product exceeds that of any two other cities in the United States. The industry employs about 1,800 hands, the capital invested is about $2,000,000, and the value of the product is estimated to be $2,750,000 annually. The six leading concerns are as follows :

LAKE ERIE IRON COMPANY, ... Whiskey Island.
LAMSON & SESSIONS COMPANY, . . Scranton Avenue.
UPSON NUT COMPANY, ... Jennings Avenue.
COLWELL & COLLINS NORWAY BOLT COMPANY,
Girard Street.
CHAPIN BOLT AND NUT COMPANY, Division, cor. Rector.
BOURNE & KNOWLES M'F'G COMPANY, . Main Street.

THE NATIONAL MALLEABLE CASTINGS COMPANY.—Cleveland is the headquarters of the malleable iron industry of this country. The largest works of this kind in the United States are located here. They are a part of the National Malleable Castings Company, in which the Malleable Iron Works of Chicago, Indianapolis and Toledo were united in January, 1891. The parent establishment in Cleveland, which was the first to be erected west of the Alleghanies, was founded in 1868, with a capital of $50,000, by Mr. A. A. Pope, who is now at the head of the combined works, having a capital of $3,000,000 and employing 3,000 workmen. The officers of the National concern and its managing directors reside in Cleveland, the business in Chicago, Indianapolis and Toledo being conducted by resident agents.

The Cleveland plant, which was formerly known as the Cleveland Malleable Iron Works, comprises ten acres near the intersection of Woodland avenue and the Cleveland & Pittsburgh Railway, covered with substantial buildings, which are equipped with specially designed machinery.

The business of the company consists in making malleable iron castings to order by the air furnace process. Their product is largely used instead of wrought iron forgings and common cast iron in the manufacture of agricultural implements and machinery, and in the construction of railway cars.

One important branch of the business of the Cleveland works is the manufacture of castings, called wheel flanges, used in the construction of wheels for vehicles. These they produce in a variety of sizes and ship to all parts of the United States and Canada.

Malleable iron is also largely used in the construction of railway cars, this use being a recent development of the business; the suitability of the material for this purpose has, however, been fully established, and the resulting economy in the building of cars has been fully recognized by car mechanics and builders.

THE EBERHARD MANUFACTURING COMPANY was established in 1879 for the manufacture of malleable castings used in the carriage, wagon and saddlery industries. The company is capitalized at $400,000 and employs about 1,000 hands; the premises cover thirteen acres and include thirty buildings. The product is marketed both at home and abroad. A. A. Pope, president.

THE CLEVELAND HARDWARE COMPANY manufactures shapes, rolled from muck bar and steel, for wagon, carriage and sleigh hardware. It employs 200 men and has a capacity of 8,500 net tons annually. The works contain one heating furnace with a gas producer, and one ten inch train of rolls.

These two concerns have a product valued at no less than $4,750,000 annually.

THE AVERY STAMPING COMPANY manufacture steel hollow ware for working utensils and elevator buckets, which are seamless and are stamped into shape from sheet steel. Eight tons of sheet steel are cut up daily. These are the only works in the country making heavy goods of this kind. The machinery is of special design. The goods are of fine quality, and reach the trade through the Bronson Supply Co. The export trade is large.

THE PECK, STOW & WILCOX COMPANY occupies an entire block on Seneca and Cuyahoga streets. This company, which also has works at Southington, Plantsville and East Berlin, Conn., is the largest concern in the world in its special line, the manufacture of hardware of every conceivable pattern for the trade. The plant in Cleveland employs 400 hands; it has two cupolas of 1,500 and 2,500 lbs. capacity respectively, furnaces, hammers and improved machinery. The engine is of 350 horse power. The company is noted for its line of tinners' tools and machines, which are in demand in Australia, Japan, China, India and other parts of the world.

THE GOBEILLE PATTERN COMPANY has the largest pattern works in the world, and manufactures patterns of every size and description. The machinery as a rule is specially designed for the business, the men employed are experts in their line, and the work systematically divided into specialties. This concern was the first to employ women at making patterns for castings and to use automatic machinery in that branch. The works are at the corner of Leonard and Winter streets. Jos. Leon Gobeille, general manager.

SPECIAL TOOLS.

WARNER & SWASEY. — This firm is composed of Worcester R. Warner and Ambrose Swasey. Their works are located on the C. & P. R. R., near Euclid Ave. Station. These were built by them in 1881 and are especially adapted for their class of work. The equipment is exceptionally fine, including some delicate apparatus. They manufacture machine tools for iron and brass work. One of the important features of their machine tool business is the complete line of brass working machinery, small tools and fixtures for the equipment of shops, for manufacturing steam, water and gas brass goods, many of the important manufactories in the country being equipped with a full line of their tools. A general assortment of their machine tools is usually kept in stock.

In addition to their work in the manufacture of machine tools they also have an important department for astronomical instruments. At their works was designed the great 26-inch equatorial telescope and its entire equipment, with 40-foot elevating floor and 45-foot dome, for the United States New Naval Observatory, Washington, D. C.

The 36-inch Lick telescope, located on Mt. Hamilton, California, now the largest in the world, was also designed and constructed at this establishment, and they

WORKS OF WARNER & SWASEY.

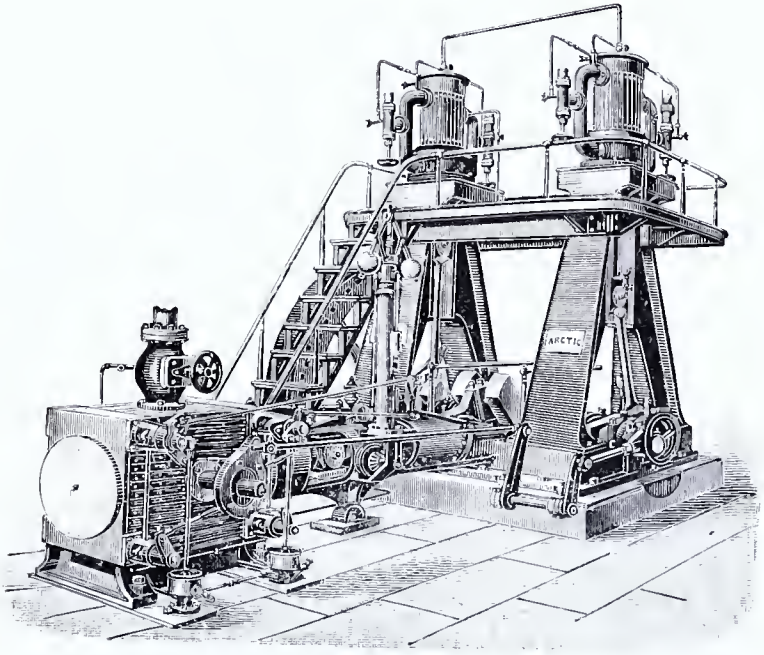
now have in process of construction, the great Yerkes telescope for the University of Chicago, the object glass of which is 40 inches in diameter, the total weight of the instrument being 75 tons.

The firm has recently been awarded a contract by the United States government for a meridian circle for the New Naval Observatory. This circle weighs over a ton, and the gear teeth in its circumference are cut under microscopic observation to a precision equaling that of the finest graduating machine. Other astronomical instruments for colleges and private observatories are in process of construction, among them being two 12-inch equatorials, one for Dudley Observatory at Albany, N. Y., and the other for the American College at Beyrout, Syria, both of these instruments being adapted for visual and photographic work.

Visitors interested in any lines of their manufacture are always welcome to their works.

CLEVELAND TWIST DRILL CO. — These works were founded in 1874, and make a specialty of twist drills, which have acquired an enviable reputation. The proprietors are J. D. Cox, Jr., and Francis F. Prentiss. They also manufacture reamers, taps, and machinists' tools.

THE STANDARD TOOL CO. has located its works on Central avenue, at the crossing of the C. & P. R. R. In addition to the usual plant, it has recently installed a Thompson electric welding machine, driven by a 250 H. P. engine and capable of welding bars of four square inches cross section. The company manufacture the increase-twist drill in all sizes, and



ARCTIC ICE MACHINE.

special tools, reamers, sockets, chucks, taps, milling cutters, etc. The officers are: Charles W. Bingham, president; H. P. McIntosh, treasurer; E. C. Palmer, secretary and general manager.

THE ARCTIC ICE MACHINE MANUFACTURING COMPANY. — The production of ice by artificial processes was a laboratory experiment for many years before it was tried on a commercial scale. Many devices were tried, but it was in Cleveland forty years ago that the first ice machine was built and operated, embodying those principles which have been successful in the ice machine of to-day. The machine is double-acting, discharging gas at both ends of the stroke. Ammonia is the refrigerating agent employed. The engines which drive the pumps are part of the machine. While the compression cylinders are always vertical, the engine is either vertical or horizontal, according to type of machine. The company builds its engines and machines complete. The demand for these machines comes from all parts of the world. They are used either to manufacture ice, or to reduce the temperature of rooms to a certain standard, as in breweries, warehouses, steamships, etc. The works are located on West street; the general office in the Perry-Payne building. Martyn Bonnell, president and treasurer; Frank Wilson, vice-president and general manager; Peter Neff, Jr., engineer.

SEWING MACHINES AND CABINETS.

There are manufactured annually in Cleveland about 150,000 sewing machines, an output greater than that of any other one city.

THE WHITE SEWING MACHINE CO. was incorporated in 1876; it has a capital of $1,235,000; it employs 1,000 operatives and turns out 100,000 machines annually. The factory is on Canal street, is 60 x 500 ft. and three stories high. There is also a screw factory on Central avenue run by the same company. The White machine is in demand both in America and Europe, as well as in Central America and Australia.

THE STANDARD SEWING MACHINE CO. build a rotary shuttle machine of great excellence. The factory is located on Cedar avenue, at the C. & P. R. R., the large four-story brick buildings, 175 x 200 ft., and adjacent grounds, being fully occupied. About 50,000 machines of various patterns and sizes are turned out annually.

THE CABINET WORKS OF THEODORE KUNDTZ were established in 1875. The buildings, which are on West Centre street, cost $100,000 and are equipped with one of the largest and most complete wood-working plants in Ohio. About 500 hands are employed and 6,000,000 feet of choice lumber are cut up annually into sewing machine cabinets.

PETROLEUM PRODUCTS.

The refining of petroleum is an industry which in Cleveland ranks next to the manufacture of iron in importance.

THE STANDARD OIL COMPANY was first organized in this city. Its immense refineries are still in operation here, and the business of these works as well as of those located at other points is largely managed by Cleveland officers. The crude oil is brought to the city by pipe lines from both east and west, and is here worked into every form for illuminating, lubricating and manufacturing purposes. The works of this company in Cleveland alone represent an actual capital of $3,500,000. The Cleveland officers are: Frank Rockefeller, vice-president; L. H. Severance, treasurer, and F. B. Squire, secretary.

There are ten other large refineries of oil in the city, having an aggregate capital of about $2,500,000 and an annual product valued at $4,000,000, including the gasolines, naphthas, illuminating oils, paraffine and dark lubricating oils, paraffine wax, etc. These ten firms are:

SCHOFIELD, SHURMER & TEAGLE.

CLEVELAND REFINING COMPANY.

NATIONAL REFINING COMPANY.

GLOBE OIL COMPANY.

EXCELSIOR REFINING COMPANY.

EAGLE REFINING COMPANY.

BROOKS OIL COMPANY.

MERIAM & MORGAN PARAFFINE COMPANY.

CANFIELD OIL COMPANY, and

CASE, NUTT & COMPANY.

THE GRASSELLI CHEMICAL COMPANY.—A general chemical manufacturing business is carried on by five concerns in Cleveland, the largest of which is the Grasselli Chemical Company. These works were founded here on account of the iron and oil industries, which create a large demand for chemicals. There are also five productive establishments, from which the census office makes returns under the head of drugs and chemicals. These ten establishments, according to the census, are capitalized at $1,366,368, employ 304 hands, and produced in 1890 goods to the value of $944,737. Among the products in chemicals are sulphuric acid, muriatic acid, nitric acid, aqua ammonia, refined glycerine, blue vitriol, sal-soda and sulphate of soda. In this industry is also included the manufacture of carbonic acid, oxygen and hydrogen gas, coal tar, cements for roofing, etc.

ELECTRIC CARBONS.

THE NATIONAL CARBON COMPANY dates from 1886. From the small beginnings of hand-made work the business has grown to an output valued at more than one million dollars annually. The old works at the foot of Willson avenue are outgrown and a new plant has been constructed on West Madison avenue covering thirty acres of ground, housed in twelve handsome brick buildings, and comprising a large amount of new and ingeniously contrived machinery specially designed for this business. The product includes moulded carbons for high tension arc; forced carbons adapted to low tension arc; hollow treated carbons for arc lamps on incandescent circuits, and cored carbons of the highest grade. Also carbon brushes, copper-coated carbon plates for batteries, carbon cups, buttons, disks, etc. The goods find sale in all parts of the world. The great bulk of the raw material from which the carbons are made is the refuse coke of the oil stills. The works employ 650 hands. The officers are W. H. Lawrence, president; B. F. Miles, vice pres.; C. M. Barber, general manager and engineer.

BEREA QUARRY NO. 6.

STONE QUARRIES.

THE CLEVELAND STONE COMPANY was incorporated July, 1886, and purchased the quarries of ten different companies which had been working in competition with each other. It has since absorbed several other quarries. It has a paid up capital of $3,250,000. The officers are James M. Worthington, president; George H. Worthington, sec. and treas.; Jas. Nichol, gen. supt.; George A. McArthur, asst. sec., and E. A. Merritt, auditor and asst. treas. The general offices are in the Wilshire building, Superior street.

The Berea quarries were first opened in 1836. For fifteen years thereafter the output was mainly used for grindstones, and this branch of the business has steadily increased to the present time. The product now consists of building stone, sawed and split flagging, curbing and grindstones. About 74 acres have been quarried out, while the company owns 151 acres of stone on which no quarrying has yet been done. Up to 1889 the depth usually excavated was only 24 feet, when, by boring, it was discovered that there are 63 feet of good merchantable stone below that depth. In the Berea quarries the company employs 175 men, 46 steam derricks, 46 steam hoisters, 19 boilers, 16 engines, 12 channelling machines, 18 steam drills, 11 steam pumps, 6 turning lathes for grindstones, and 3 saw-mills, with

6, 15 and 18 gangs of saws respectively (ten of these have screw feeds, the rest box-balance feeds). There is one 46-inch turbine wheel, one grindstone-frame factory, a complete electric light plant for all the mills and a large machine shop containing lathes, planers, shapers, etc. Berea is 12 miles southwest of Cleveland on the "Big Four" and Lake Shore railways. The company operates eight distinct quarries there.

The company also operates one quarry at West View, one at Columbia, one at Olmsted Falls, several at Oberlin (which are grouped as No. 5), several at North Amherst and vicinity, one at Brownhelm and one at Wakeman. These quarries are ranged along the line of the Lake Shore railroad and are all in the same geological formation, known as the Berea grit. The company has another quarry at Peninsula, 22 miles south of Cleveland, producing grindstones, and a large property of 600 acres at Grindstone City, on Lake Huron, State of Michigan. The company is largely interested in quarries in Southern Ohio, in Arkansas, New Hampshire and Vermont. It owns several quarries in northern Ohio which are not at present operated and are not described in this article. The company employs in all over 2,000 men, 142 derricks, 130 steam hoisters, 64 boilers, 52 engines, 40 channelling machines, 55 steam drills, 37 steam pumps, 36 grindstone-turning lathes, 11 saw-mills with 72 gangs of saws. All the machinery is modern and of high standard.

The business has steadily increased. In 1891, the shipments amounted to 29,736 carloads of stone, of which over 2,000 carloads were of grindstones. The later years show still greater results. The company

has permanent depots in Cleveland, Chicago, Boston and New York, where large stocks of grindstones are carried, and branch offices in Pittsburgh, Philadelphia, Rochester and Toronto.

INSTITUTIONS OF LEARNING.

CASE SCHOOL OF APPLIED SCIENCE, founded by the late Leonard Case, was incorporated in 1880. The main building was erected in 1885, the chemical laboratory and mechanical laboratory more recently. The physical and electrical laboratories are in the main building. The grounds are on Euclid avenue, opposite Wade Park. The school is well equipped and is doing excellent work. The number of students is rapidly increasing and the school is already known to the world through some of its graduates. Case School provides eight regular courses of study, each one requiring four years for completion, viz: Civil Engineering, Mechanical Engineering, Electrical Engineering, Mining Engineering, Physics, Chemistry, Architecture, General Science. Practical work in the laboratories, shops and field is made a prominent feature. Cady Staley, president.

THE WESTERN RESERVE UNIVERSITY is an old educational institution, comprising Adelbert College,

Cleveland Medical College, Cleveland School of Law, College of Dentistry, Conservatory of Music, and Cleveland College for Women.

THE CLEVELAND HOMŒOPATHIC HOSPITAL COLLEGE is another large Medical School.

HOTELS.

The principal hotels of the city are :

THE HOLLENDEN. — Superior and Bond streets. American and European plan. Fire-proof.

THE STILLMAN.—Euclid avenue, near Erie street. American plan. Fire-proof.

THE WEDDELL.—Superior and Bank streets. American and European plan.

THE KENNARD.—St. Clair and Bank streets.

THE FOREST CITY HOUSE.—Superior street and Public Square.

THE AMERICAN HOUSE.—Superior street, near Bank street.